Ordering number: EN 5247

Thick Film Hybrid IC

SANYO

No. 5247

STK400-490

3ch AF Power Amplifier (Split Power Supply) 25W + 50W + 25W, THD = 0.4%

Overview

The STK400-490 is an audio power amplifier IC for multichannel speaker applications. It comprises two 25W channels (left and right) and a 50W channel (center) in a single package. It is fully pin compatible with the 3-channel output devices (STK400-×00 series) and 2-channel output devices (STK401-×00 series). In addition, it supports 6/3Ω output load impedance.

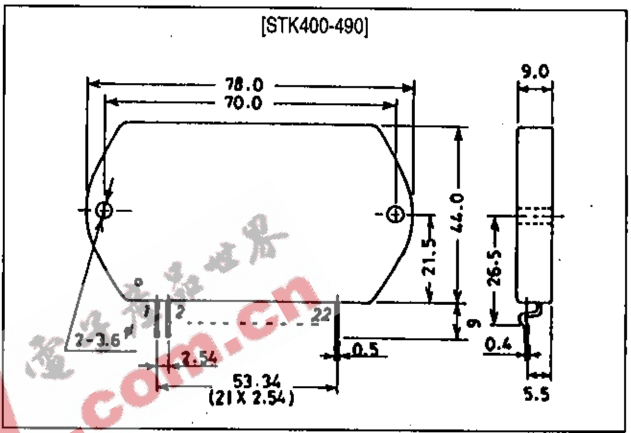
Features

- Pin compatible with the 3-channel output devices (STK400-×00 series) and 2-channel output devices (STK401-×00 series)
- Output load impedance R_L = 6/3Ω supported
- Pin configuration grouped into individual blocks of inputs, outputs and supply lines to minimize the adverse effects of pattern layout on operating characteristics.
- Few external components

Package Dimensions

unit: mm

4086A



Specifications

Maximum Ratings at Ta = 25°C

Parameter	Channel	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	L, R	V_{CC} max (1)		±36	V
	C	V_{CC} max (2)		±47	V
Thermal resistance	L, R	θj-c (1)	Per power transistor	2.1	°C/W
	C	θj-c (2)	Per power transistor	1.7	°C/W
Junction temperature		Tj		150	°C
Operating substrate temperature		Tc		125	°C
Storage temperature		Tstg		–30 to +125	°C
Available time for load short-circuit	L, R	t_s (1)	V_{CC} = ±25V, R_L = 6Ω, f = 50Hz, P_O = 25W	1	s
	C	t_s (2)	V_{CC} = ±32V, R_L = 6Ω, f = 50Hz, P_O = 50W	1	s

SANYO Electric Co., Ltd. Semiconductor Business Headquarters
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110 JAPAN

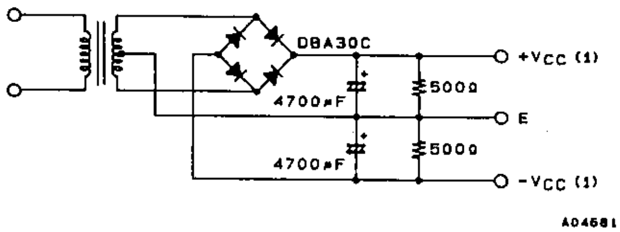
Operating Characteristics at Ta = 25°C, R_L = 6Ω (noninductive load), Rg = 600Ω, VG = 40dB

Parameter	Channel	Symbol	Conditions	min	typ	max	Unit
Output power	L, R	$P_O(1)$	V_{CC} = ±25V, f = 20Hz to 20kHz, THD = 0.4%	25	30	–	W
	C	$P_O(2)$	V_{CC} = ±32V, f = 20Hz to 20kHz, THD = 0.4%	50	55	–	W
	L, R	$P_O(3)$	V_{CC} = ±21V, f = 1kHz, THD = 1.0%, R_L = 3Ω	25	30	–	W
	C	$P_O(4)$	V_{CC} = ±26V, f = 1kHz, THD = 1.0%, R_L = 3Ω	50	55	–	W
Total harmonic distortion	L, R	THD(1)	V_{CC} = ±25V, f = 20Hz to 20kHz, P_O = 1.0W	–	–	0.4	%
			V_{CC} = ±25V, f = 1kHz, P_O = 5.0W	–	0.02	–	%
	C	THD(2)	V_{CC} = ±32V, f = 20Hz to 20kHz, P_O = 1.0W	–	–	0.4	%
			V_{CC} = ±32V, f = 1kHz, P_O = 5.0W	–	0.01	–	%
Frequency response	L, R	$f_L, f_H(1)$	V_{CC} = ±25V, P_O = 1.0W, $^{+0}_{-3}$dB	–	20 to 50k	–	Hz
	C	$f_L, f_H(2)$	V_{CC} = ±32V, P_O = 1.0W, $^{+0}_{-3}$dB	–	20 to 50k	–	Hz
Input impedance	L, R	$r_i(1)$	V_{CC} = ±25V, f = 1kHz, P_O = 1.0W	–	55	–	kΩ
	C	$r_i(2)$	V_{CC} = ±32V, f = 1kHz, P_O = 1.0W	–	55	–	kΩ
Output noise voltage	L, R	$V_{NO}(1)$	V_{CC} = ±30V, Rg = 10kΩ	–	–	1.2	mVrms
	C	$V_{NO}(2)$	V_{CC} = ±39V, Rg = 10kΩ	–	–	1.2	mVrms
Quiescent current	L, R	$I_{CCO}(1)$	V_{CC} = ±30V	20	60	100	mA
	C	$I_{CCO}(2)$	V_{CC} = ±39V	10	30	50	mA
Neutral voltage	L, R	$V_N(1)$	V_{CC} = ±30V	–70	0	+70	mV
	C	$V_N(2)$	V_{CC} = ±39V	–70	0	+70	mV

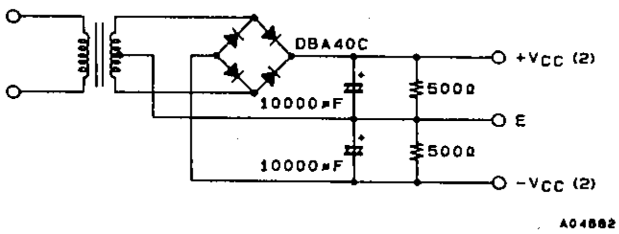
Notes.
All tests are measured using a constant-voltage supply unless otherwise specified.
Available time for load short-circuit and output noise voltage are measured using the transformer supply specified below.
The output noise voltage is the peak value of an average-reading meter with an rms value scale (VTVM). A regulated AC supply (50Hz) should be used to eliminate the effects of AC primary line flicker noise.

Specified Transformer Supplies

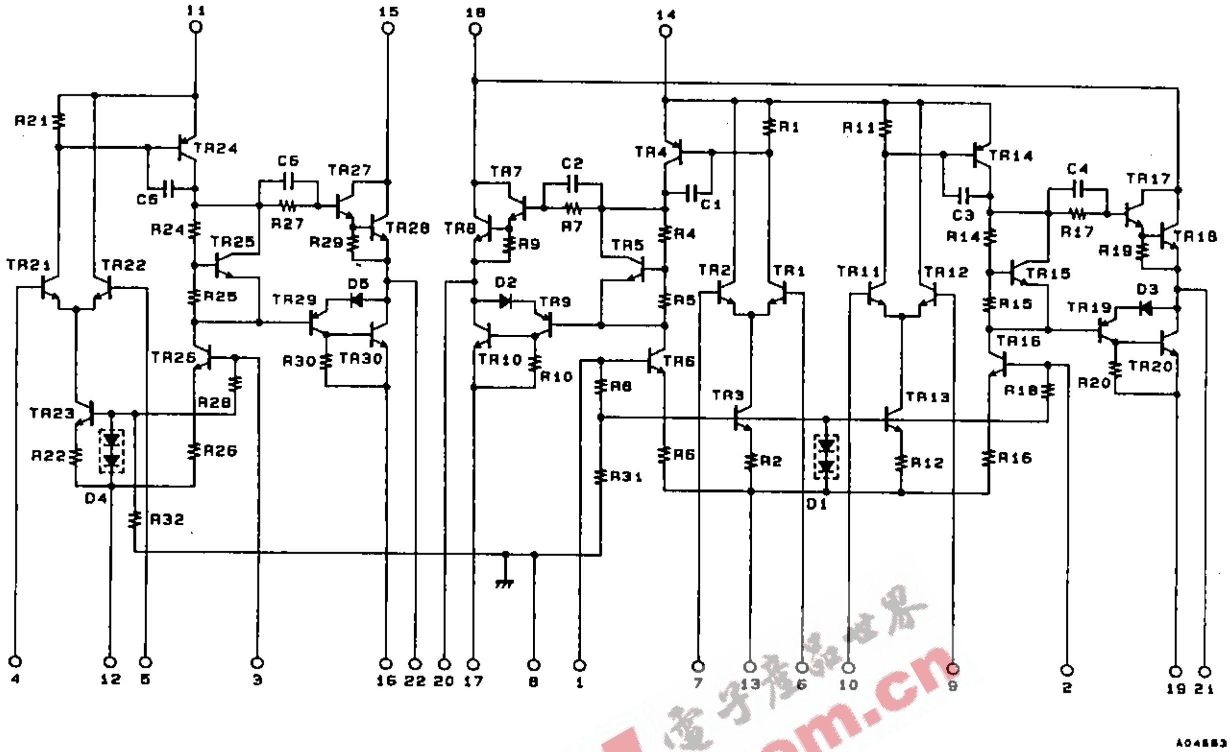
(L, R ch: RP-25 or Equivalent)



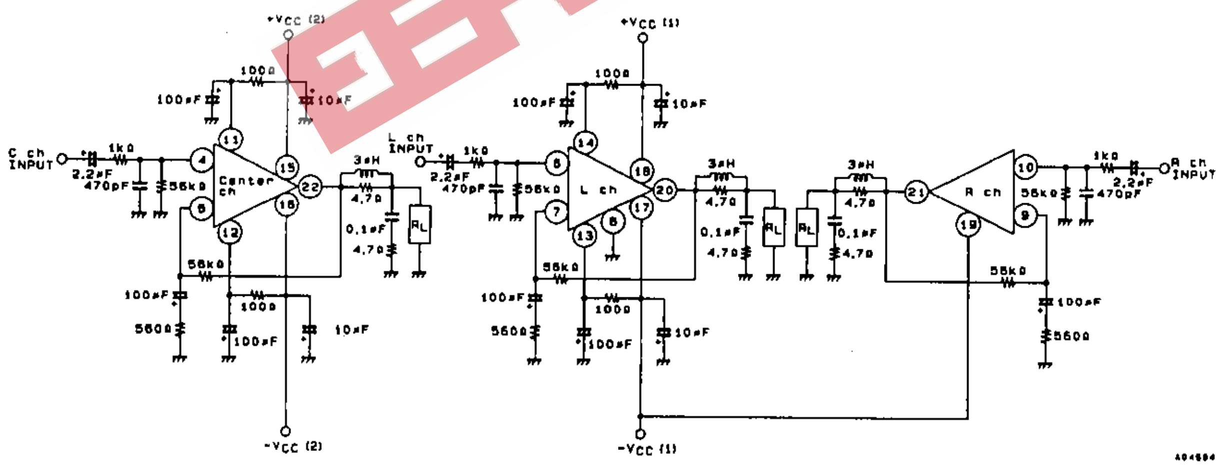
(C ch: MG-200 or Equivalent)



Equivalent Circuit



Sample Application Circuit



Series Configuration

These devices form a series of pin-compatible devices with different number of output channels, output ratings and total harmonic distortion. Some of these devices are under development. Contact your Sanyo sales representative if you require more detailed information.

STK400-000, STK400-200 series (3-channel, same output rating)					STK401-000, STK401-200 series (2-channel)					Supply voltage [V][1]			
Type No.	THD [%]	Type No.	THD [%]	Rated output	Type No.	THD [%]	Type No.	THD [%]	Rated output	V_{CC} max1	V_{CC} max2	$V_{CC}1$	$V_{CC}2$
STK400-010		STK400-210		10W × 3	STK401-010		STK401-210		10W × 2	–	±26.0	±17.5	±14.0
STK400-020		STK400-220		15W × 3	STK401-020		STK401-220		15W × 2	–	±29.0	±20.0	±16.0
STK400-030		STK400-230		20W × 3	STK401-030		STK401-230		20W × 2	–	±34.0	±23.0	±19.0
STK400-040		STK400-240		25W × 3	STK401-040		STK401-240		25W × 2	–	±36.0	±25.0	±21.0
STK400-050		STK400-250		30W × 3	STK401-050		STK401-250		30W × 2	–	±39.0	±26.0	±22.0
STK400-060		STK400-260		35W × 3	STK401-060		STK401-260		35W × 2	–	±41.0	±28.0	±23.0
STK400-070	0.4	STK400-270	0.08	40W × 3	STK401-070	0.4	STK401-270	0.08	40W × 2	–	±44.0	±30.0	±24.0
STK400-080		STK400-280		45W × 3	STK401-080		STK401-280		45W × 2	–	±45.0	±31.0	±25.0
STK400-090		STK400-290		50W × 3	STK401-090		STK401-290		50W × 2	–	±47.0	±32.0	±26.0
STK400-100		STK400-300		60W × 3	STK401-100		STK401-300		60W × 2	–	±51.0	±35.0	±27.0
STK400-110		STK400-310		70W × 3	STK401-110		STK401-310		70W × 2	±56.0	–	±38.0	–
					STK401-120		STK401-320		80W × 2	±61.0	–	±42.0	–
					STK401-130		STK401-330		100W × 2	±65.0	–	±45.0	–
					STK401-140		STK401-340		120W × 2	±74.0	–	±51.0	–

STK400-400, STK400-600 series (3-channel, different output ratings)						Supply voltage [V][1]			
Type No.	THD [%]	Type No.	THD [%]	Rated output		V_{CC} max1	V_{CC} max2	$V_{CC}1$	$V_{CC}2$
STK400-450		STK400-650		Cch	30W	–	±39.0	±26.0	±22.0
				Lch, Rch	15W	–	±29.0	±20.0	±16.0
STK400-460		STK400-660		Cch	35W	–	±41.0	±28.0	±23.0
				Lch, Rch	15W	–	±29.0	±20.0	±16.0
STK400-470		STK400-670		Cch	40W	–	±44.0	±30.0	±24.0
				Lch, Rch	20W	–	±34.0	±23.0	±19.0
STK400-480		STK400-680		Cch	45W	–	±45.0	±31.0	±25.0
				Lch, Rch	20W	–	±34.0	±23.0	±19.0
STK400-490	0.4	STK400-690	0.08	Cch	50W	–	±47.0	±32.0	±26.0
				Lch, Rch	25W	–	±36.0	±25.0	±21.0
STK400-500		STK400-700		Cch	60W	–	±51.0	±35.0	±27.0
				Lch, Rch	30W	–	±39.0	±26.0	±22.0
STK400-510		STK400-710		Cch	70W	±56.0	–	±38.0	–
				Lch, Rch	35W	–	±41.0	±28.0	±23.0
STK400-520		STK400-720		Cch	80W	±61.0	–	±42.0	–
				Lch, Rch	40W	–	±44.0	±30.0	±24.0
STK400-530		STK400-730		Cch	100W	±65.0	–	±45.0	–
				Lch, Rch	50W	–	±47.0	±32.0	±26.0

1. V_{CC} max1 (R_L = 6Ω), V_{CC} max2 (R_L = 3 to 6Ω), $V_{CC}1$ (R_L = 6Ω), $V_{CC}2$ (R_L = 3Ω)

Heatsink Design Considerations

The heatsink thermal resistance, θc-a, required to dissipate the STK400-490 device total power dissipation, Pd, is determined as follows:

Condition 1: IC substrate temperature not to exceed 125°C.

Pd (total) × θc-a + Ta < 125°C .... (1)

Pd (total) = Pd (L) + Pd (R) + Pd (C)

where Ta is the guaranteed maximum ambient temperature, Pd (total) is the total power dissipation, Pd (L) is the left-channel power dissipation, Pd (R) is the right-channel power dissipation and Pd (C) is the center-channel power dissipation.

Condition 2: Power transistor junction temperature, Tj, not to exceed 150°C.

Pd (total) × θc-a + [Pd (L) + Pd (R)]/N
× θj-c + Ta < 150°C .... (2)

Pd (total) × θc-a + Pd (C)/N′
× θj-c′ + Ta < 150°C .... (3)

where N is the left and right-channel number of power transistors, N′ is the center-channel number of power transistors, θj-c is the left and right-channel power transistor thermal resistance per transistor, and θj-c′ is the center-channel power transistor thermal resistance per transistor. Note that the power dissipated per transistor is the total, Pd, divided evenly among the N power transistors.

Expressions (1), (2) and (3) can be rewritten making θc-a the subject.

θc-a < (125 – Ta)/Pd (total) .... (1)′

θc-a < (150 – Ta)/Pd (total) – [Pd (L) + Pd(R)]
× θj-c/[Pd (total) × N] .... (2)′

θc-a < (150 – Ta)/Pd (total) – Pd (C) ×
θj-c′/[Pd (total) × N′] .... (3)′

The heatsink required must have a thermal resistance that simultaneously satisfies all three expressions.

The heatsink thermal resistance can be determined from (1)′, (2)′ and (3)′ once the following parameters have been defined.

- Supply voltage: V_{CC}
- Load resistance: R_L
- Guaranteed maximum ambient temperature: Ta

The total device power dissipation when STK400-490 $V_{CC}(1) = \pm 25V$, $V_{CC}(2) = \pm 32V$ and $R_L = 6\Omega$, for a continuous sine wave signal, is a maximum of 42.5W (left + right channels) and 34.3W (center channel), as shown in the "Pd — P_O" characteristics graphs.

When estimating the power dissipation for an actual audio signal input, the rule of thumb is to select Pd corresponding to (1/10) × P_O max (within safe limits) for a continuous sine wave input. For example,

Pd (L) + Pd (R) = 25W [for (1/10) × P_O max = 2.5W]

Pd (C) = 21.6W [for (1/10) × P_O max = 5W]

Pd (total) = Pd (L) + Pd (R) + Pd (C) = 46.6W

The STK400-490 has 4 left + right-channel power transistors (N), 2 center-channel power transistors (N′), left + right-channel thermal resistance per transistor (θj-c) is 2.1°C/W, and center-channel thermal resistance per transistor (θj-c′) is 1.7°C/W. If the guaranteed maximum ambient temperature, Ta, is 50°C, then the required heatsink thermal resistance, θc-a, is:

From expression (1)′:

θc-a < (125 – 50)/46.6
< 1.60

From expression (2)′:

θc-a < (150 – 50)/46.6 – 25 × 2.1/(46.6 × 4)
< 1.86

From expression (3)′:

θc-a < (150 – 50)/46.6 – 21.6 × 1.7/(46.6 × 2)
< 1.75

Therefore, to satisfy all three expressions, the required heatsink must have a thermal resistance less than 1.6°C/W.

Similarly, when STK400-490 $V_{CC}(1) = \pm 21V$, $V_{CC}(2) = \pm 26V$ and $R_L = 3\Omega$,

Pd (L) + Pd (R) = 30W [for (1/10) × P_O max = 2.5W]

Pd (C) = 25.5W [for (1/10) × P_O max = 5W]

Pd (total) = Pd (L) + Pd (R) + Pd (C) = 55.5W

From expression (1)′:

θc-a < (125 – 50)/55.5
< 1.35

From expression (2)′:

θc-a < (150 – 50)/55.5 – 30 × 2.1/(55.5 × 4)
< 1.51

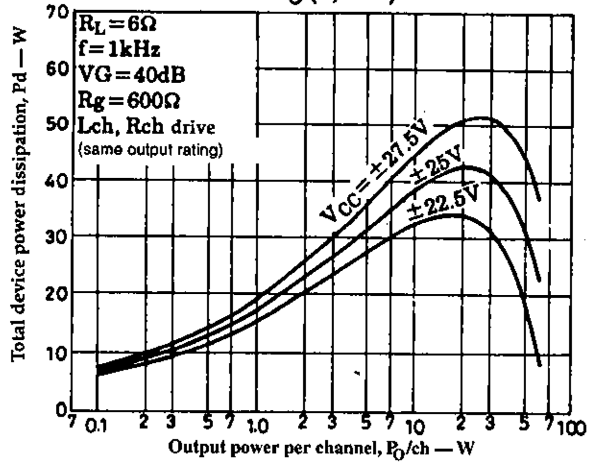
From expression (3)′:

θc-a < (150 – 50)/55.5 – 25.5 × 1.7/(55.5 × 2)
< 1.41

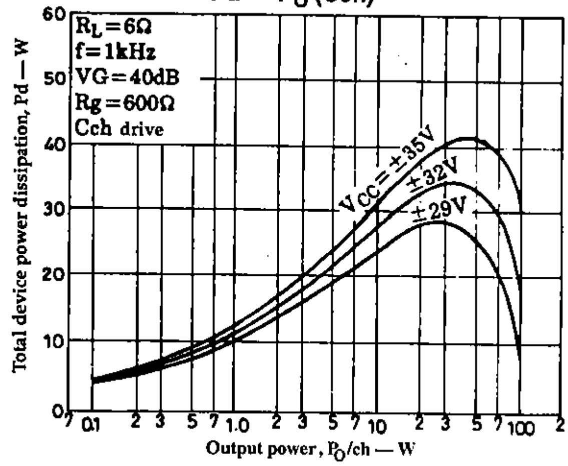
Therefore, to satisfy all three expressions, the required heatsink must have a thermal resistance less than 1.35°C/W.

This heatsink design example is based on a constant-voltage supply, and should be verified within your specific set environment.

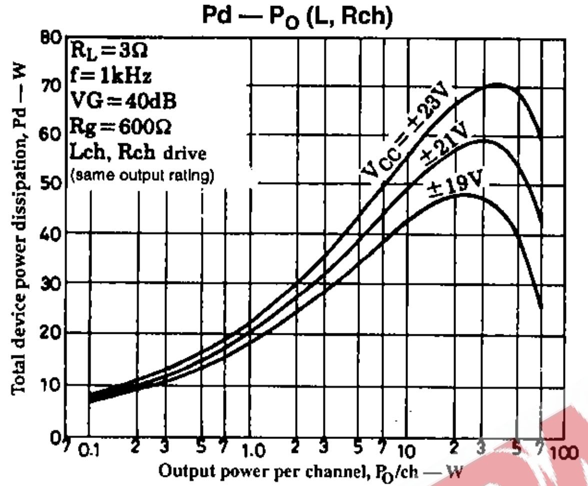
Pd — P_O (L, Rch)



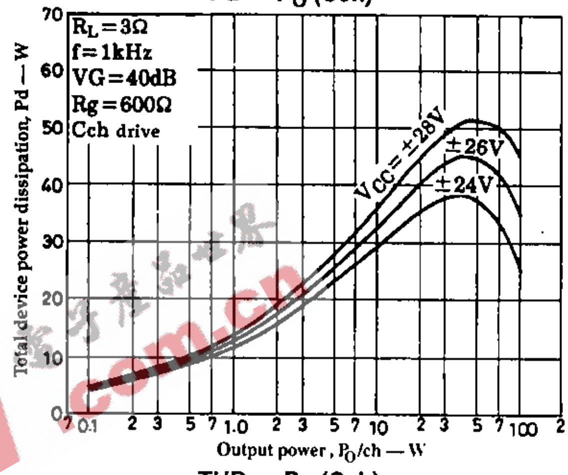
Pd — P_O (Cch)



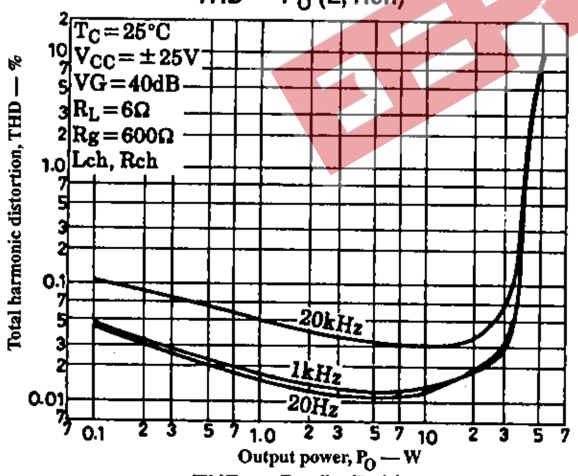
Pd — P_O (L, Rch)



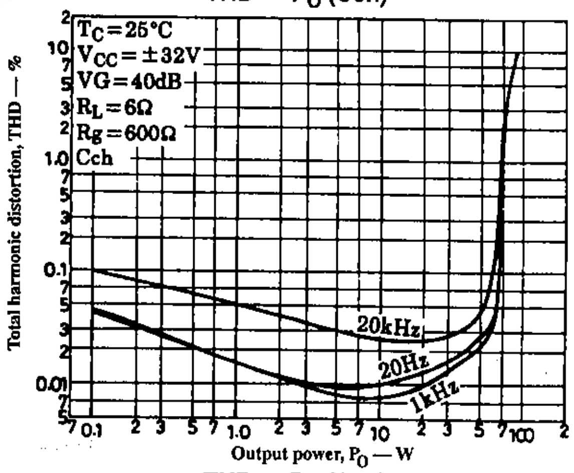
Pd — P_O (Cch)



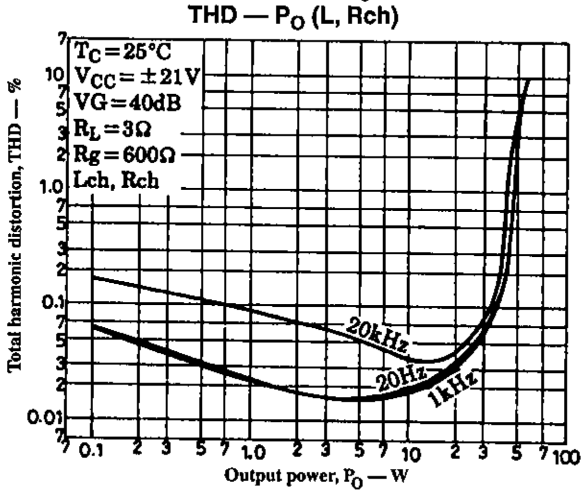
THD — P_O (L, Rch)



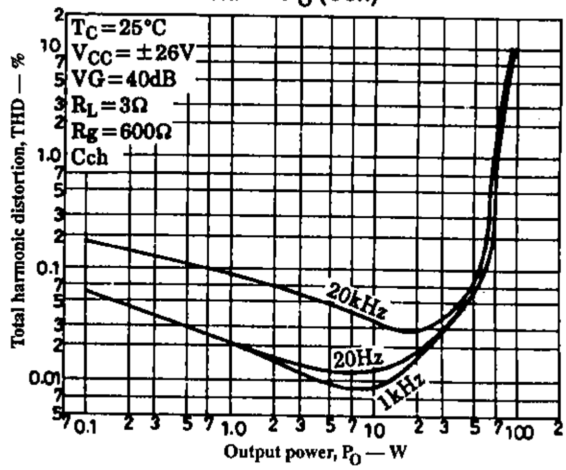
THD — P_O (Cch)



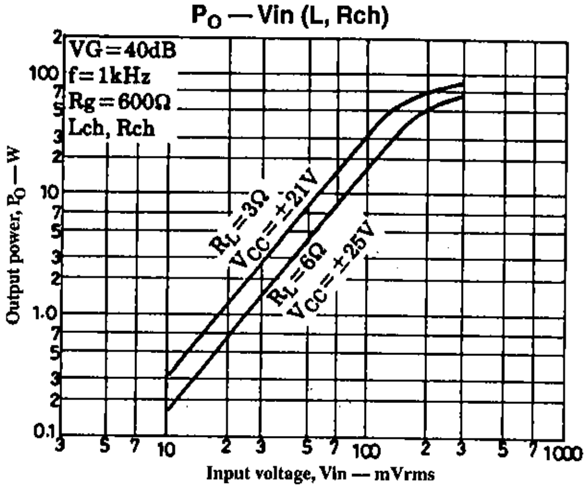
THD — P_O (L, Rch)



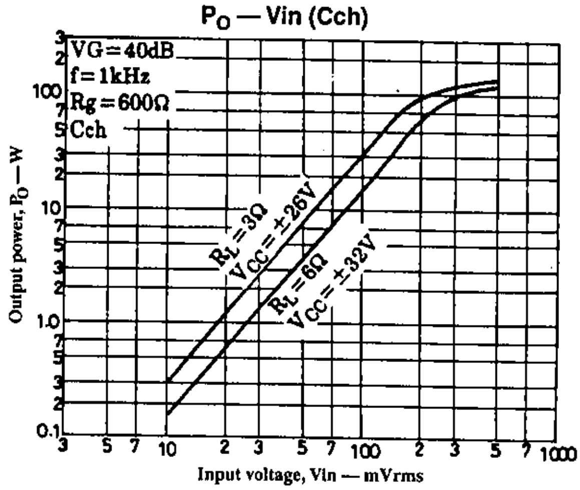
THD — P_O (Cch)



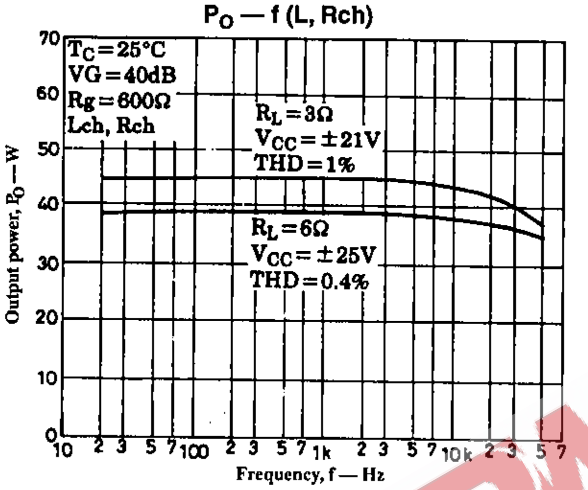
P_O — Vin (L, Rch)



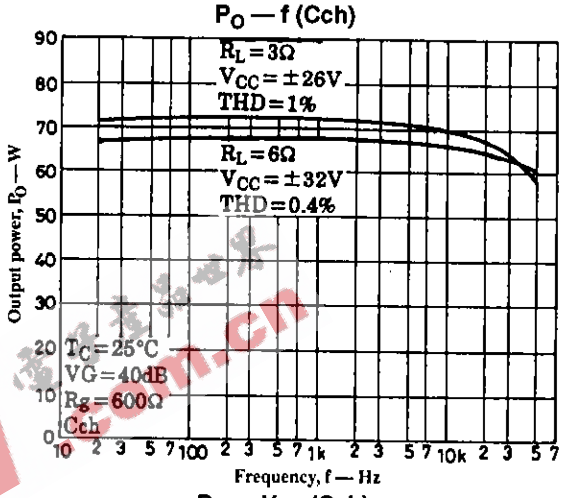
P_O — Vin (Cch)



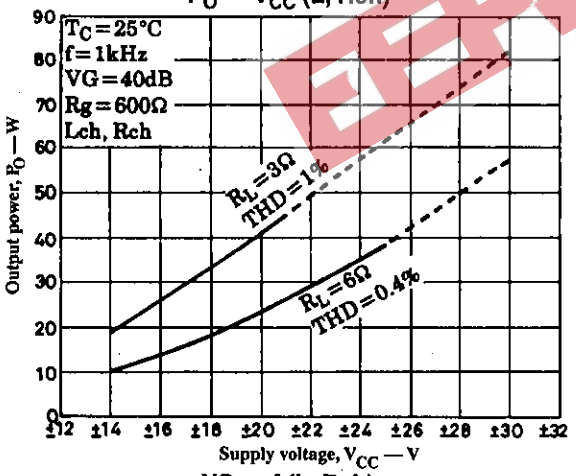
P_O — f (L, Rch)



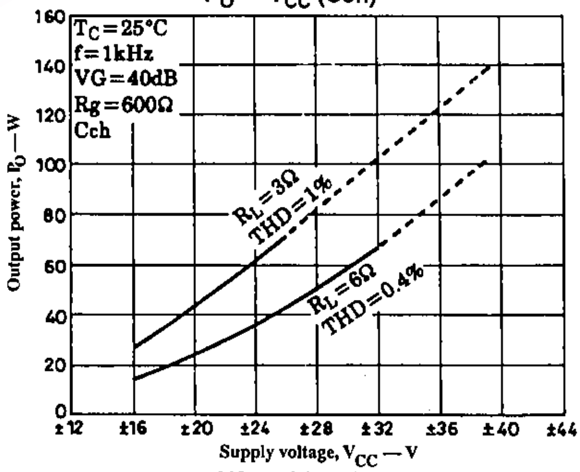
P_O — f (Cch)



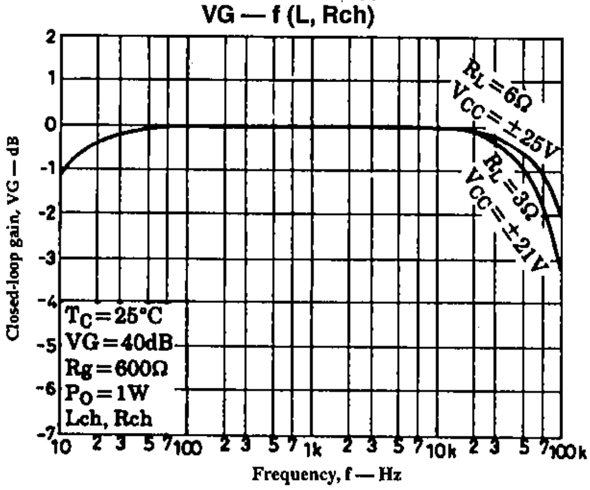
P_O — V_{CC} (L, Rch)



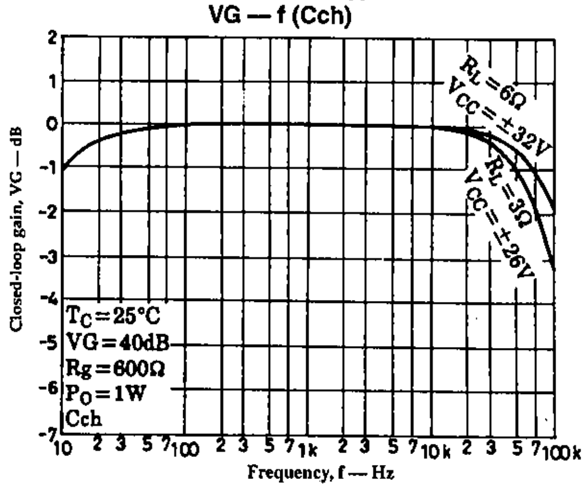
P_O — V_{CC} (Cch)

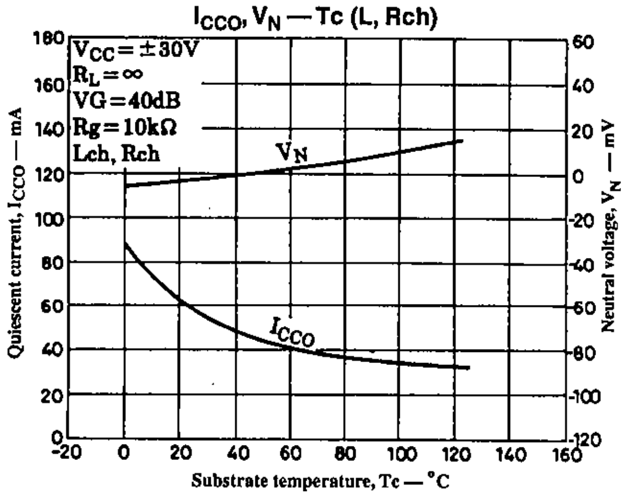


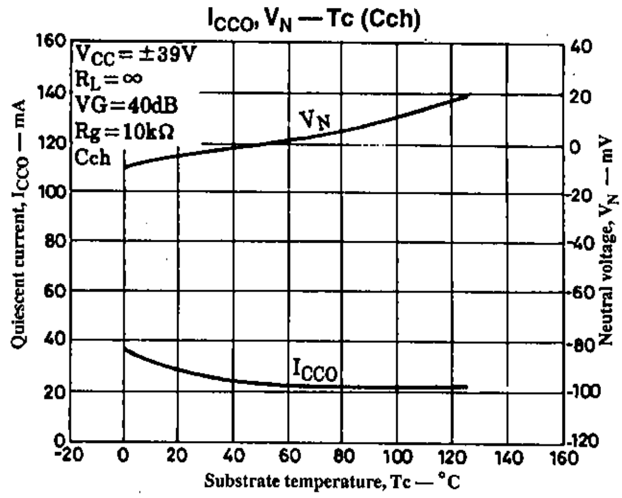
VG — f (L, Rch)

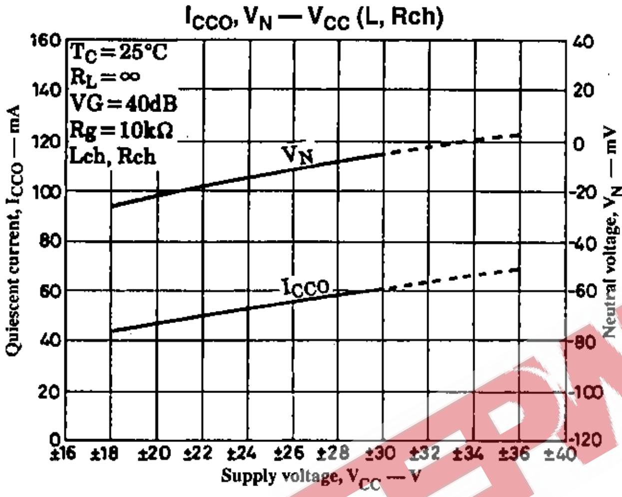


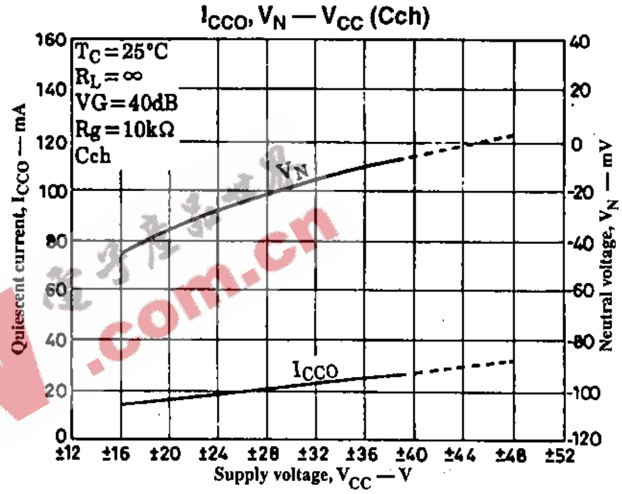
VG — f (Cch)




ICCO, VN — Tc (L, Rch)
VCC=±30V
RL=∞
VG=40dB
Rg=10kΩ
Lch, Rch
VN
ICCO
Quiescent current, ICCO — mA
Neutral voltage, VN — mV
Substrate temperature, Tc — °C


ICCO, VN — Tc (Cch)
VCC=±39V
RL=∞
VG=40dB
Rg=10kΩ
Cch
VN
ICCO
Quiescent current, ICCO — mA
Neutral voltage, VN — mV
Substrate temperature, Tc — °C


ICCO, VN — VCC (L, Rch)
TC=25°C
RL=∞
VG=40dB
Rg=10kΩ
Lch, Rch
VN
ICCO
Quiescent current, ICCO — mA
Neutral voltage, VN — mV
Supply voltage, VCC — V


ICCO, VN — VCC (Cch)
TC=25°C
RL=∞
VG=40dB
Rg=10kΩ
Cch
VN
ICCO
Quiescent current, ICCO — mA
Neutral voltage, VN — mV
Supply voltage, VCC — V